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Effect of integrated nutrient management on growth, yield and quality of onion (*Allium cepa* L.) cv. Palam Lohit

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Abstract

The experimental study entitled "Effect of integrated nutrient management on growth, yield and quality of onion (*Allium cepa* L.)" was carried out at the experimental farm of Department of Horticulture, Doon (PG) College of Agriculture Science & Technology, Selaqui, Dehradun, Uttarakhand in the Rabi season of 2017-2018. The objective of the study was to investigate the effect of different treatments on growth, yield and quality of onion cv. 'Palam Lohit'. In this study, 10 treatments, *viz*. T1: Control: RDF (FYM @ 250 q ha^{-1} and NPK- 125:76:60 kg ha^{-1}), T2: RDF (NPK) + VC @ 8 t ha^{-1}, T3: 75 % RDF + Azotobacter, T4: 75 % RDF + Azotobacter + VAM, T5: 50 % RDF + Azotobacter, T6: 50 % RDF + Azotobacter + VAM, T7: VC @ 8 t ha^{-1} + Azotobacter + VAM, T8: FYM @ 25 t ha^{-1} + Azotobacter + VAM, T9: VC @ 4 t ha^{-1} + Azotobacter + VAM and T10: FYM @ 12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM, were compared in a Randomized Complete Block Design (RCBD) having three replications with a plot size of 3.0 x 1.5 m^2 and a plant spacing of 15 cm x 10 cm. The observations were recorded on leaf length (cm), no. of leaves per plant, bulb yield per plot (kg), bulbs yield per hectare (q), total soluble solid (°Brix) and neck thickness (cm). The results revealed that T4 (75 % RDF + Azotobacter + VAM) was rated as the best treatment for majority of characters like leaf length (cm), no. of leaves per plant, bulb yield per plot (16.80 kg), bulb yield per hectare (373.33 q) followed by T2. Therefore, on the basis of present study, it is concluded that application of biofertilizers (Azotobacter and VAM) in combination with 75 % RDF can be suggested cost effective combination for enhanced growth, yield and quality onion production in mid hills of Uttarakhand.

Keywords: nutrient management on growth, yield and quality of onion

Introduction

Onion (*Allium cepa* L.) is one of the most important commercial vegetable crops cultivated extensively in India and it belongs to family Alliaceae. Onion is considered to be the second most important vegetable crop grown in the world after tomato. Onion is liked for its flavor. The pungency in onion is due to presence of a volatile oil 'allyl propyl disulphide'- organic compound rich in sulphur. The beneficial compound called 'quercetin' present in onion is a powerful antioxidant. Maharashtra is the leading producer state of onion in India. In India, onion is grown over an area of 1270.36 thousand hectares with a production of 215.63 lakh tonnes and in Uttarakhand, onion is grown over an area of 4.08 thousand hectares with a production of 41.61 thousand tonnes. (Anonymous, 2017) [1].

After the green revolution, production of vegetables has increased to a great extent due to use of chemical fertilizers, but their indiscriminate use has led to soil sickness, ecological hazards and depletion of non-renewable sources of energy. To overcome the problems of ecological imbalance and increased cost of cultivation due to continuous use of chemical fertilizers, the latest trend of growing vegetable crops by using organic manure, biofertilizers together with inorganic fertilizers is called as integrated nutrient management (INM). (Rahman *et al.* 2013) [10].

Use of organic manure and biofertilizers in conjunction with chemical fertilizers has been found to be promising not only in sustaining higher productivity but also providing stability in crop production. The farmyard manure seems to act directly for increasing crop yield by accelerating the respiratory process through cell permeability or by hormones through growth action. In recent years, use of vermicompost has been advocated in integrated nutrient management (INM) system in vegetable crops. Use of vermicompost as an organic manure and substitute for chemical fertilizer is advised by the pioneers of organic farming. Biofertilizers are products containing living cells of different types of microorganism, which have an ability to convert nutritionally important elements to available form through biological processes. (Vijaykumar *et al.* 2000; Ramakrishnan and Thamizhiniyan 2004) [12, 11].

Further, knowing the deleterious effect of using only chemical fertilizers on soil health, use of chemical fertilizers supplemented with organic waste and biofertilizers will be environmentally benign. Therefore, biofertilizers are widely accepted as low cost supplements to chemical fertilizers with no deleterious effect either on soil health or environment (Bhagyaraj and Suvarna, 1999) [2].

Among biofertilizers, Azotobacter strains play a key role in harnessing the atmospheric nitrogen through its fixation in the roots. VAM symbiosis facilitates plant growth through enhancing uptake of several macro and micro nutrients of low mobility in soil, like phosphorus, zinc, copper etc. (Dipankar, 2010) [4].

Availability of nitrogen is important for growing plants as it is major indispensable constituent of protein and nucleic acid. The application of nitrogen with different doses increased plant growth and yield of onion (Patel *et al.* 1992) [8]. Phosphorus has its beneficial effect on early root development, plant growth, yield and quality. Potassium plays an important role in crop productivity. Keeping in view the significance of above aspects, the main objectives of study is to work out the possibility of reducing the use of chemical fertilizers by application of organic manures and bio-fertilizers.

Materials and Methods

The present study was carried out at Vegetable Research Farm of the Department of Horticulture, Doon (PG) College of Agriculture Science & Technology, Selaqui, Dehradun, Uttarakhand in the Rabi season of 2017-2018. The experimental site is located at an elevation of 450 meters above mean sea level lying between latitudes 29 °58' N and longitudes 77° 34' E. The experimental field was thoroughly ploughed with the help of tractor followed by planking few days prior to actual date of transplanting. Stones, pebbles and residues of previous crop were removed manually. The experiment consisted of ten treatments which were laid out in randomized complete block design with three replications. The nursery of variety Palam Lohit was sown on 15th November 2017. Eight weeks old, uniform and healthy seedlings were transplanted on 5th January 2018 in the plots at a spacing of 15cm x 10 cm on plot size of 3.0 m x 1.5 m and thus accommodating 300 plants /plot. The inorganic fertilizers in the form of Urea, SSP and MOP were applied in the respective treatment. NPK was applied as per the treatment, in which 1/3rd dose of nitrogen along with full doses of phosphorus and potassium were incorporated in soil before the transplanting of seedlings. The remaining dose of nitrogen for each treatment was given in two splits; after 30 and 60 DAT. Biofertilizers (*Azotobacter* and *Arbuscular mycorrhizae*) were procured from Punjab Kheti Bari Centre, Landra Road, Kharar (Distt. Mohali), Punjab. Biofertilizer application was done through root dip method (0.5 kg of Azotobacter in 10 liters of water for one hectare) and soil application method (10 kg VAM mixed with 10 times FYM). Three hand weedings were done to keep the crop free from weeds. Irrigations were given as per crop requirement. All other cultural operations and plant protection measures were adopted to maintain uniform plant population and ideal conditions for proper growth and development of plants. The matured crop was harvested on 6th June 2018. Under growth parameters, observations on leaf length, number of leaves, and neck thickness were taken. Under yield parameters, bulb yield was recorded. The length of leaf of ten plants was recorded with the help of scale from bulb neck to tip of leaf when held vertically and the average was worked out. The numbers of fully opened, grown and green leaves were counted and average was worked out from ten randomly selected plants. The neck thickness below the joint of leaf lamina was measured with the help of Vernier caliper for the selected ten plants and the average was worked out. The bulbs were harvested from each plot and total bulb weight was recorded. The bulb weight was expressed as bulb yield per plot in kilogram. To calculate the bulb yield per hectare on basis of yield per plot, following formula was used:

$$\text{Bulb yield (q ha}^{-1}) = \frac{\text{Yield per plot (kg)}}{\text{Area of the plot (m}^2)} \times 100$$

Total soluble solids content of fresh bulbs was recorded with the help of hand refractometer and was expressed as °Brix. Randomly ten bulbs were analyzed and average was calculated. The statistical analysis was carried out for each observed character under study, using MS-Excel and OPSTAT packages. The data recorded under field conditions were analyzed using randomized complete block design (RCBD) (Gomez and Gomez, 1984) [5].

The details of the treatments is as under

T1: Control: RDF (FYM @ 250 q ha-1 and NPK @ 125:76:60 kg ha-1)
T2: RDF (NPK) + VC @ 8 t ha-1
T3: 75 % RDF + Azotobacter
T4: 75 % RDF + Azotobacter + VAM
T5: 50 % RDF + Azotobacter
T6: 50 % RDF + Azotobacter + VAM
T7: VC @ 8 t ha-1 + Azotobacter + VAM
T8: FYM @ 25 t ha-1 + Azotobacter + VAM
T9: VC @ 4 t ha-1 + Azotobacter + VAM
T10: FYM @12.5 t ha-1 + VC @ 4 t ha-1 + Azotobacter + VAM

Results and Discussion

Growth and yield parameters

1. Leaf length at 60 and 90 DAT (cm)

From the table 1, it was reported that at 60 DAT, the average leaf length (38.92 cm) was maximum in treatment T4 (75 % RDF + Azotobacter + VAM) which was statistically at par with T2 [RDF (NPK) + VC @ 8 t ha^{-1}], T3 (75 % RDF + Azotobacter) and T1 (control). However, minimum leaf length (26.16 cm) was recorded in treatment T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM).

At 90 DAT, maximum leaf length (55.97 cm) was found in treatment T4 (75 % RDF + Azotobacter + VAM) which was statistically at par with T2 [RDF (NPK) + VC @ 8 t ha^{-1}]. Minimum leaf length (33.92 cm) was seen in treatment T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM). The findings of experimental study were in agreement with the findings of Jawadagi *et al.* (2012) [6].

Table 1: Effect of INM on leaf length (cm) of onion at different stages of crop growth in Onion

	Treatment	60 DAT	90 DAT
		2017-18	2017-18
T1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})	34.83	47.41
T2	RDF (NPK) + VC @ 8 t ha^{-1}	37.93	53.01
T3	75 % RDF + Azotobacter	37.22	47.95
T4	75 % RDF + Azotobacter + VAM	38.92	55.97
T5	50 % RDF + Azotobacter	31.93	42.23
T6	50 % RDF + Azotobacter + VAM	32.66	43.40
T7	VC @ 8 t ha^{-1} + Azotobacter + VAM	28.20	38.32
T8	FYM @ 25 t ha^{-1} + Azotobacter + VAM	26.16	33.92
T9	VC @ 4 t ha^{-1} + Azotobacter + VAM	27.11	35.07
T10	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM	30.61	39.81
	Mean	35.56	43.74
	C.D.$_{(0.05)}$	4.91	4.03

2. Number of leaves per plant at 60 and 90 DAT

At 60 DAT, the highest number of leaves per plant (5.17) were produced by the treatment T4 (75 % RDF + Azotobacter + AM) and it was statistically at par with treatment T3, T2, T1, T5, T6, T10 and T7. The lowest number of leaves per plant (4.17) was found in treatment T8 (FYM @ 25 t ha^{-1}+ Azotobacter + VAM) (Table 2).

Similarly, at 90 DAT, the highest number of leaves per plant (6.23) were recorded in treatment T4 (75 % RDF + Azotobacter + VAM) which was statistically at par with T3 and minimum (4.90) were recorded in T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM). Similar findings were also reported by Yogita *et al.* (2012) [14, 15] and Kumar *et al.* (2010) [7]. Possible reason for increased number of leaves per plant may be due to the improvement in growth related attributes because of certain growth promoting substances secreted by biofertilizers, better uptake of water, nutrients and their transportation.

3. Neck thickness (cm)

From table 3, maximum neck thickness (0.94 cm) was recorded in treatment T2 [RDF (NPK) + VC @ 8 t ha^{-1}] which was statistically at par with T4 (75 % RDF + Azotobacter + VAM). However, minimum neck thickness (0.57 cm) was observed in treatment T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM). The results are in agreement with the work of Yogita *et al.* (2012) [14, 15] and Kumar *et al.* (2010) [7].

Table 2: Effect of INM on number of leaves per plant at different stages of crop growth in onion

	Treatment	60 DAT	90 DAT
		2017-18	2017-18
T1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})	4.83	5.4
T2	RDF (NPK) + VC @ 8 t ha^{-1}	4.93	5.6
T3	75 % RDF + Azotobacter	5.07	5.8
T4	75 % RDF + Azotobacter + VAM	5.17	6.23
T5	50 % RDF + Azotobacter	4.83	5.3
T6	50 % RDF + Azotobacter + VAM	4.7	5.37
T7	VC @ 8 t ha^{-1} + Azotobacter + VAM	4.6	5.10
T8	FYM @ 25 t ha^{-1} + Azotobacter + VAM	4.17	4.90
T9	VC @ 4 t ha^{-1} + Azotobacter + VAM	4.33	4.97
T10	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM	4.63	5.07
	Mean	4.73	5.37
	C.D.$_{(0.05)}$	0.59	0.52

Table 3: Effect of INM on neck thickness (cm) in onion

	Treatment	Neck thickness (cm.)
		2017-18
T1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})	0.75
T2	RDF (NPK) + VC @ 8 t ha^{-1}	0.94
T3	75 % RDF + Azotobacter	0.84
T4	75 % RDF + Azotobacter + VAM	0.87
T5	50 % RDF + Azotobacter	0.79
T6	50 % RDF + Azotobacter + VAM	0.75
T7	VC @ 8 t ha^{-1} + Azotobacter + VAM	0.63
T8	FYM @ 25 t ha^{-1} + Azotobacter + VAM	0.57
T9	VC @ 4 t ha^{-1} + Azotobacter + VAM	0.70
T10	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM	0.68
	Mean	0.75
	C.D.$_{(0.05)}$	0.07

4. Bulb yield per plot (kg)

Table 4 represents that the maximum bulb yield per plot (16.80 kg) was obtained when the RDF was reduced by 25 % along with the application of biofertilizers (T4) which was statistically at par with T2 [RDF (NPK) + VC @ 8 t ha^{-1}] and T3 (75 % RDF + Azotobacter) and minimum bulb yield per plot (8.53 kg) was observed in T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM).

5. Bulb yield per hectare (q)

It is evident from the data presented in Table 4 that the highest bulb yield per hectare (373.33 q) was recorded in treatment T4 (75 % RDF + Azotobacter + VAM) which was statistically at par with T2 [RDF (NPK) + VC @ 8 t ha^{-1}] and T3 (75 % RDF + Azotobacter). However, the minimum yield was found in treatment T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM).

Data recorded among the organic treatments in the experiment shows that maximum yield (230.37 q) was obtained in treatment T10 (FYM @ 12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM) and minimum yield (189.63 q) was found in treatment T8 (FYM @ 25 t ha^{-1} + Azotobacter + VAM).

Similar findings were also reported by Ragland *et al.* (1989) [9], Yadav *et al.* (2012) [13] and Yogita *et al.* (2012) [14, 15]. This increase is due to more number of bulbs, bulb size and average weight of bulbs. Use of Azotobacter and VAM not only makes the atmospheric nitrogen and soil phosphorus available, respectively, to plants but also enhances the plant growth and bulb yield due to release of hormones, vitamins and nutrients.

Table 4: Effect of INM on bulb yield per plot (kg) and per hectare (q) in onion bulb

	Treatment	Bulb yield per plot (kg)	Bulb yield per hectare (q)
		2017-18	2017-18
T1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})	13.47	299.26
T2	RDF (NPK) + VC @ 8 t ha^{-1}	16.33	362.97
T3	75 % RDF + Azotobacter	15.73	349.63
T4	75 % RDF + Azotobacter + VAM	16.80	373.33
T5	50 % RDF + Azotobacter	11.50	255.56
T6	50 % RDF + Azotobacter + VAM	11.87	263.70
T7	VC @ 8 t ha^{-1} + Azotobacter + VAM	9.70	215.56
T8	FYM @ 25 t ha^{-1} + Azotobacter + VAM	8.53	189.63
T9	VC @ 4 t ha^{-1} + Azotobacter + VAM	8.70	193.33
T10	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM	10.37	230.37
	Mean	12.30	273.33
	C.D.$_{(0.05)}$	1.75	38.82

Quality parameters

1. Total Soluble solids (°Brix)

From table 5, the highest total soluble solids (10.20 °Brix) were recorded in treatment T3 (75 % RDF + Azotobacter) which was statistically at par with T4, T2, T6, T1, T5, T8 and T7. At the same time, minimum total soluble solids (8.83 °Brix) were found in treatment T9. Closely related results were found by Yogita and Ram (2012) [14, 15] and Brinjh *et al.* (2014) [3]. The possible cause depicted for the increase in TSS content with the application of inorganic fertilizers in combination with biofertilizers, over recommended dose of NPK, may be more utilization of inorganic nitrogen in the presence of biofertilizers, better development of root system and possibly higher synthesis of plant growth hormones. So, it may have helped in increasing the sugar content in the bulb.

Table 5: Effect of INM on total soluble solids (°B) in onion

	Treatment	Total soluble solids (°B)
		2017-18
T1	Control: RDF (FYM @ 250 q ha^{-1} and NPK @ 125:76:60 kg ha^{-1})	9.75
T2	RDF (NPK) + VC @ 8 t ha^{-1}	9.93
T3	75 % RDF + Azotobacter	10.20
T4	75 % RDF + Azotobacter + VAM	10.04
T5	50 % RDF + Azotobacter	9.62
T6	50 % RDF + Azotobacter + VAM	9.79
T7	VC @ 8 t ha^{-1} + Azotobacter + VAM	9.42
T8	FYM @ 25 t ha^{-1} + Azotobacter + VAM	9.60
T9	VC @ 4 t ha^{-1} + Azotobacter + VAM	8.83
T10	FYM @12.5 t ha^{-1} + VC @ 4 t ha^{-1} + Azotobacter + VAM	8.99
	Mean	9.62
	C.D.$_{(0.05)}$	0.83

Conclusion

It was concluded from the above study that all the inorganic INM combination treatments were statistically superior over the organic INM combination treatments. On the basis of experiment conducted, it is concluded that treatment T4 i.e., application of 75 % RDF + Azotobacter + VAM was found superior among all other treatments for growth, yield and quality characters of onion. Therefore, 75 % RDF + Azotobacter + VAM may be recommended for profitable crop production of onion. The present research work was carried out at a single location i.e. at the Vegetable Research Farm, Department of Horticulture, Doon (PG) College of Agriculture Science and Technology, Selaqui, Dehradun, Uttarakhand during one season only (Rabi, 2017-18). Further, trials of this research work in different locations of the Uttarakhand are needed to recommend the results for use at farmer’s level. Thus, the use of 75 % RDF in combination with biofertilizers (Azotobacter and VAM) would be a sound integrated nutrient management practice as a cost effective combination for higher yields, quality produce and to improve the fertility status of the soil.

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